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(54) SILENCER FOR EXPANDING GASES

(71) We, MESSERSCHMITT-BOLKOW-BLOHM GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, of 8000 München, West Germany, a Company organised and existing under the laws of Western Germany, do hereby declare the invention, for which we pray that a patent may be graned to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a silencer for expanding gases which is of the kind intended to dampen the kinetic energy of the emerging gas molecules and thus the noise produced by their turbulent flow into the surrounding air.

Systems are known in which the gases are caused to pass through porous layers with a high flow resistance.

In these silencers (so called "throttle" type silencers) a high pressure builds up upstream of the porous layer, but rapid acting pneumatic plant with a high air throughout cannot be fitted with such silencers. A further drawback is that the high-frequency noise occurring in the accumulation chamber of the silencer, owing to the turbulence of the gas, is absorbed hardly at all by the hard porous layer which is provided next to the first mentioned porous layer but emerges to produce undesirable noise, so that these silencers ensure only a slight reduction in the sound level relative to their size.

The primary object of this invention is to enable a relatively great reduction to be obtained in the sound level for the dimensions of the silencer, without appreciably impeding the gas throughout.

In accordance with the invention we provide a tubular silencer comprising a closed end and an open end through which in use gas enters axially and thence into a central gas accumulation chamber through a perforated baffle plate disposed adjacent to the said open end, a first tubular layer of porous sound-absorbing material at least partially defining the accumulation chamber and through the wall of which the gas which has passed through the baffle plate passes in diffuse fashion, and a second tubular layer of impermeable material provided with a predetermined arrangement of perforations surrounding the first layer to allow the gas emerging from the first layer to escape in a direction transversely of the axis of the second tubular layer through the perforations of the second layer.

Preferably the second layer is surrounded by a third tubular layer of porous sound-absorbing material and through the wall of which the gas which has passed through the perforations of the second layer passes in diffuse fashion, and the third tubular layer is surrounded by a fourth tubular layer of impermeable material provided with a predetermined arrangement of perforations to allow the gas emerging from the third layer to escape in a direction transversely of the axis of the fourth tubular layer through the perforations of the fourth layer.

This preferred arrangement ensures that the gas between the "throttle" apertures formed by the perforations af the second and fourth layers passes through the intermediate third layer which will generally have finer pores and be more resilient and thus more sound absorbent than either of the second and fourth layers. The gas gives up substantially no kinetic energy to the resilient intermediate pore walls on impact. The oscillation energy due to the turbulence caused in the interior of the silencer is also absorbed in this third layer.

Preferably the number of the "throttle" channels in the first layer is far greater than the number of "throttle" apertures in the second layer. Similarly, where third and fourth layers are provided the number of "throttle" channels in the third layer is preferably far greater than the number of the "throttle" apertures in the fourth layer. This increases considerably the distance covered by the molecules of air as they pass through the layers and intensifies the energy absorption. The currents of air which diffuse through the first layer are caused to re-unite in order to pass through the perforations in the second layer as a result of

which the effective distance covered is increased.

Similarly, where third and fourth layers are provided the currents of air which diffuse through the third layer are caused to re-unite in order to pass through the perforations in the fourth layer as a result of which the effective distance covered is increased. Where both second and fourth layers are provided it is of advantage for the perforations (i.e. the throttle apertures) of the second and fourth layers to be relatively offset. The sound-absorbent porous material used can consist of an open-pored foam synthetic plastics material such as polyether foam plastics material. It is also of advantage for the perforated impermeable material to consist of a perforated synthetic plastics material such as P.V.C. This has the advantage that owing to the considerable self-damping of plastics material, only little sound is reflected from the tubular housing itself and the corrosion-resisting properties are improved.

The tubular layers forming the wall of the tubular silencer can take the form of concentric hollow cylinders, in which case the horizontal projection of the hollow cylinder may form a circle or, for technical production reasons, a regular polygon. The second or fourth of the said tubular layers may define a tubular housing of the silencer. The first layer and/or third layer may be prefabricated.

The baffle plate may be constructed so as to divert and disperse the gas flowing therethrough. This baffle plate preferably presents a concave shape to the incident gas, and preferably it has an outer annular zone containing a large number of holes. This ensures that a jet of gas will make impact on an inner part of the baffle plate made free of holes and that the flow will disperse. Where a silencer housing is provided the said closed end of the tube may be provided by a cover having a part which extends into the housing and serves to clamp one or more of the said tubular layers when the cover closes the said end; one or more of the said tubular layers may be united with the cover prior to insertion in the housing.

An example of the invention will now be described with reference to the accompanying drawing which is a section through a silencer.

The gas after entering the silencer through inlet 11 first encounters the radially inner surface of a concave baffle plate 5, causing turbulence, and then enters an accumulation chamber 9 *via* holes 8 in the baffle plate 5. On passing through the randomly orientated numerous "throttle" channels 4, first of an inner porous layer 2 (first tubular layer), the gas loses kinetic energy. In addition, the porous layer 2 of resilient sound-absorbing material absorbs noise caused by the turbulence in the interior of the silencer. A subsequent inner layer 1 (second tubular layer), with fewer "throttle" apertures 3 but arranged in parallel regular fashion recombines some of the separate flows, which were first caused to fan out, while a following outer porous layer 2^1 (third tubular layer), with its randomly orientated numerous fine "throttle" channels 4^1, again causes the flow to fan out. The gas thus loses further energy, and the vorticity noise is further absorbed. After further re-combination by the "throttle" apertures 3^1 arranged in parallel regular fashion in the outermost layer 1^1 (fourth tubular layer) the flow of gas emerges to atmosphere.

The silencer has a cover 6 secured to its end opposite the inlet in a suitable manner as shown by rivets. The cover has a part which extends into the housing and which clamps the parts in the housing when the cover is in place. As shown, he outer porous layer 2^1 is held by a ring or studs 7. The inner layer 2 also can be held and as illustrated a packing piece 10 of the same material as the porous layers 2 and 2^1 is interposed between the cover 6 and inner layer 2.

Further the layers 2 and 2^1 could be combined with the cover 6 and packing piece 10 to form a constructional assembly.

WHAT WE CLAIM IS:—

1. A tubular silencer comprising a closed end and an open end through which in use gas enters axially and thence into a central gas accumulation chamber through a perforated baffle plate disposed adjacent to the said open end, a first tubular layer of porous sound-absorbing material at least partially defining the accumulation chamber and through the wall of which the gas which has passed through the baffle plate passes in diffuse fashion, and a second tubular layer of impermeable material provided with a predetermined arrangement of perforations surrounding the first layer to allow the gas emerging from the first layer to escape in a direction transversely of the axis of the second tubular layer through the perforations of the second layer.

2. A silencer according to Claim 1, wherein the second layer is surrounded by a third tubular layer of porous sound-absorbing material and through the wall of which the gas which has passed through the perforations of the second layer passes in diffuse fashion, and the third tubular layer is surrounded by a fourth tubular layer of impermeable material provided with a predetermined arrangement of perforations to allow the gas emerging from the third layer to escape in a direction transversely of the

axis of the fourth tubular layer through the perforations of the fourth layer.

3. A silencer according to Claim 2, wherein the perforations of the second and fourth layers are offset relatively to one another.

4. A silencer according to any preceding claim, wherein the layer of porous sound-absorbing material or each such layer consists of open-pored foam synthetic plastics material.

5. A silencer according to any preceding claim, wherein the layer of perforated impermeable maerial or each said layer consists of a perforated synthetic material.

6. A silencer according to any preceding claim, wherein all of the tubular layers are concentric hollow cylinders.

7. A silencer according to any preceding claim, wherein the second or fourth of the said ubular layers defines a tubular housing of the silencer.

8. A silencer according to Claim 7, wherein the first layer and/or third layer is/are prefabricated.

9. A silencer according to Claim 7 or Claim 8, wherein the said closed end is provided by a cover having a part which extends into the housing and serves to clamp one or more of the said tubular layers when the cover closes the said end.

10. A silencer according to any preceding claim, wherein the baffle plate is so constructed as to divert and disperse the gas flowing therethrough.

11. A silencer according to Claim 10, wherein the baffle plate presents a concave shape to the incident gas.

12. A silencer according to Claim 11, wherein the baffle plate has an outer annular zone containing a large number of holes.

13. A silencer substantially as herein described with particular reference to and as shown in the accompanying drawing.

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1432048 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*